GPS DATA DICTIONARY

Note: This section is provided by David Lowe of the Cultural Resources GIS Facility, Washington, D.C.

INTRODUCTION

Earthworks management begins with reliable maps of the resources. Until the introduction of Global Positioning Systems, there was no cost-effective method for producing accurate maps of surviving earthworks. GPS allows a survey crew not only to map the locations of earthworks but also to record various attributes associated with these resources, such as relief, ground cover, and condition. This information collected in the field can then be fed into a PC-based Geographic Information Systems (GIS) program like ArcView™ or Atlas GIS™. Once mapped and in the GIS, the earthworks can be measured, buffered, and analyzed in association with other digital map layers like ground cover, soil type, vegetation type, tax parcels, and so forth. Earthworks segments can be linked to existing databases and assigned a maintenance priority according to available funding. Restoration or stabilization efforts can be recorded and tracked, so that the park retains a record even if important personnel leave or are transferred. Although many parks currently lack access to a GIS, this important tool is likely to become a standard in all parks within ten years, if not much sooner.

The first hurdle is to get the earthworks data into the computer. This can be done by conducting a GPS survey of surviving resources.

A GPS survey of earthworks for the purpose of management would be conducted in two phases: (1) Inventory and (2) Evaluation and Monitoring. A complete basic inventory of all surviving earthworks should be conducted before beginning any condition or vegetation assessments. This ensures that the park's GIS contains consistent baseline data for all surviving features before additional layers are added. A complete inventory of resources provides a foundation for all subsequent management decisions.

During the inventory phase, the earthworks are located and described. To accomplish this task, the GPS survey team needs a basic understanding of the methods and techniques of earthworks construction, a general idea of the historic context of the defenses, and the ability to identify predominant ground cover. In areas of heavy undergrowth, the inventory survey should be conducted (if possible) in fall-winter-early spring before vegetation has come out so that earthworks and related features are readily visible. The critical attribute collected is location, but the survey team should describe additional attributes that are important for interpreting and understanding the condition of the features. When designed for use with GPS, this list of descriptive attributes is called a *data dictionary*.

During the evaluation phase, vegetation is examined (sampled) at regular intervals along the linear earthwork and various condition assessments are conducted. The survey team should have a more advanced understanding of vegetation and ecology or be accompanied by a botanist. The vegetation evaluation phase can be conducted in late spring-summer-early fall, when plants can be identified and counted. For resources under forest cover, GPS surveyors can in a surprisingly short time map every tree growing out of the parapet and ditch, noting its species, size, and health. Such an inventory would be invaluable for determining an appropriate tree maintenance regime. At least once a year, GPS survey teams should revisit a park's entire inventory of earthworks to record new areas of damage. Over time, this enables resource managers to quantify threats, to identify trouble spots, and to respond to small problems before these cause more serious resource damage.

FEATURES AND ATTRIBUTES COLLECTED DURING GPS INVENTORY SURVEY OF EARTHWORKS

Line Feature: Parapet

Earthworks are linear features that reflect the deployment of military formations on the ground. Earthworks were sited according to principles of military science and therefore reveal much about the thinking and activities of the officers and soldiers who constructed them. Although many specific types of earthworks were built during the Revolution, War of 1812, and the Civil War (redans, lunettes, redoubts, parallels, rifle trenches), all consisted of a parapet (a mound of earth) and a ditch from which the dirt to form the parapet was excavated.

A GPS survey team approaches these features generically, mapping each segment of parapet as a line that follows the course of the parapet, turning off the line where the feature ends and starting a new line with the next feature or segment. This generic approach allows the survey team to stick to observable features, thus minimizing interpretation in the field. The specific design of an earthworks feature can be determined later from the shape of the earthwork line on the map, its relationship to other earthworks, and from the various collected attributes, such as type of construction, relief, width of parapet, overall condition, and predominant land cover.

1. Type of Construction

Military field fortifications consisted of a parapet, which is a mound of earth, and a ditch from which the earth was excavated. A front line fortification faced in the direction that soldiers manning the earthwork pointed their rifles. Positions often received fire from more than one direction, requiring other protective works with additional facings. Communications trenches or covered ways sometimes ran at odd angles to main, front lines. The parapets of such lines were piled on the side most likely to receive fire. The facing of trenches might reverse from one side of a crest to the other as the source of incoming fire shifted from the right of the line to the left. The *front* of a line faced toward the enemy and incoming fire; the *rear* was away from the enemy.

There were three techniques of earthworks construction: front or exterior ditch; rear or interior ditch; and double ditch. Rear-ditch was the simplest and most common method of construction. Soldiers lined up along the intended course of a trench and began digging with shovels and picks or often with bayonets and tine cups. The soldiers threw the excavated earth to their front to provide a barrier of earth between themselves and the enemy. The soldiers stood in the ditch to fire over the parapet. The rear-ditch shelter trench shown here with four and a half feet relief could be constructed in about an hour and a half. If time permitted, the trench would be deepened, and the rear of the parapet could be revetted or reinforced with logs or other materials. This type of field fortification provided basic shelter for infantrymen, averaged four to five feet in relief, and is extremely common among surviving fieldworks.

The second technique used to construct field fortifications was to excavate a ditch outside of the parapet. The soldiers first constructed a retaining wall of logs or other materials, called a *revetment*. The soldiers then lined up in front, excavated earth, and threw it back against the revetment. The *front-ditch* method allowed the ditch to be deeper than a soldier could stand often six to ten feet or more. The extra earth made the parapet correspondingly thicker and stronger. This type of construction placed the parapet and the ditch between the contending parties with the ditch serving as an additional barrier to attacking troops. Always preferred by military engineers when time permitted, such works were used in semi-permanent fortifications, detached works, and artillery batteries, or to provide extra protection for infantry from incoming enemy artillery fire. Redans, lunettes, and redoubts were built this way, under the direct supervision of an engineer. Long, straight segments of front-ditch infantry parapets, called *curtains*, were often employed to connect artillery strong points.

The third type of entrenchment was built with a ditch on both sides of the parapet. *Double-ditch* construction might be used to add bulk to an existing rear-ditch parapet, to adapt to shallow topsoil, or to respond to uneven terrain. This technique was sometimes used to create a wagon road or *covered way* behind a front-ditch parapet. It is also seen where trench segments were captured and refaced or "turned" to face the opposite direction.

2. Relief

The relief of an earthwork is the vertical distance between the top of the parapet and the bottom of the ditch. Relief is an important indicator of the type of earthwork and its condition.

3. Width of Parapet

The width of the parapet is measured from the angle of the parapet where it joins the original ground surface to the angle at the bottom of the ditch. Width of parapet together with relief and length (generated from measuring the parapet line in GIS) provide the necessary descriptive dimensions for the resource.

4. Overall Condition

If the surveyor feels competent, he or she should make an overall condition assessment of the segment of trench being mapped. Much depends on the original form of the earthwork and how much it has been disturbed over the years. A simple rifle trench might be in good condition even though its relief is only three feet, whereas a larger curtain wall or battery position might be judged poor even with a surviving relief of six feet. Deep relief relative to the earthwork's original size, a well-defined parapet, and sharper, cleaner angles imply little past erosion and good surviving integrity. A wider, poorly defined parapet, shallower relief, and blurred angles at ground level, show that the parapet has eroded and spread out to fill the ditch. In extreme cases, a parapet may have eroded almost flat, leaving only the shallow remnant trough. Various intrusions through the parapet, such as logging or farm roads, would degrade the condition of a parapet segment, as would areas of erosion or other damage. A simple rating system is good, fair, poor, and remnant. While this is a subjective approach, it is useful during the inventory process to identify resources that are most in need of protection.

5. Predominant Ground Cover

It is important to collect the predominant ground cover associated with an earthwork in order to identify applicable management techniques. Collecting this information on the ground also provides a check for land cover information derived from other sources, such as aerial photographs. Past surveys have revealed that earthworks in mature forests, particularly deciduous forests, tend to retain the best integrity. In most areas, pine dominated forests indicate that the area has been recently timbered, typically causing some erosion damage. It is rarer for earthworks to survive in open areas without the protection of tree cover, but it does occur, and parks have intentionally cleared and planted areas to exhibit earthworks.

The following vegetation categories are suggested as generic enough to be used by non-specialists in a range of climatic zones: evergreen forest, mixed forest (evergreen and deciduous); deciduous forest; meadow/pasture/grassland; marsh/wetland; scrub regrowth; maintained cover (planted turf or native grasses); and other (which can be used for unclassified cover). The park's natural resource manager may use already established vegetation categories in the data dictionary, so long as the surveyors are able to distinguish differences among vegetation types.

Line Feature: Ditch

In some cases it may be appropriate to map the ditch, as well as the parapet of an earthwork. This is particularly true with large earthen structures with very wide parapets and ditches, such as a redoubt. The line should be collected along the outer lip of the ditch.

Point Feature: Earthworks Point

Civil War field fortifications comprise more than the main front lines. A fieldwork complex can include secondary defensive lines, feeder trenches, covered ways, or military roads by which to move men and supplies to the front—all which can be mapped as parapet line features. Associated with these various linear features are a variety of point features that are important for understanding the layout of the defenses. The longer a military unit stayed in an area, the more elaborate the system of fortifications tended to become. Units established command posts and hospitals. Engineers laid out artillery strong points. Supply caches were established and dug in behind the main lines adjacent to military roads. Individual soldiers constructed dugouts, shelter holes, or fire pits behind the lines. Picket or skirmish holes (era foxholes) were dug 50-200 yards in front of the main trench line to guard against a surprise assault. All of these earthworks points are important for understanding and interpreting the layout of a defensive line.

1. Gun Platform

Some of the most important features associated with entrenched lines are the locations of the artillery. With some experience, a survey team can identify and map these gun emplacements. Field guns (mobile artillery) were sometimes entrenched individually behind crescent-shaped parapets, called demilunes, just large enough to cover the gun and its crew (12-15 feet across). Four to six guns were sometimes entrenched together as a “battery”. Field guns were also incorporated into the main defensive lines. The cannon could be sighted across the parapet (as shown in the illustration) or through a gap in the parapet, called an embrasure (discussed below). Platforms for the guns behind the parapet were smoothed out and lined with planks or split logs, if time permitted, to provide a level surface for aiming and servicing the gun.

Gun positions without embrasures can be recognized in the field by several indicators: the parapet will be thickened relative to connecting rifle trenches; the ditch is usually in front and may have switched abruptly from the rear to the front when approaching the position; a rectangular platform (12 x 15 ft.) may be seen behind the parapet; traverses might have been erected on either side of the platform to protect from enfilading fire; a ramp or cut might be visible behind the platform where the gun was brought in and taken out; and a rectangular hole (3 x 4 feet) might be present 12 to 15 yards behind the platform where the gun’s ammunition chest was entrenched. Typically, some but not all of these indicators are present. The surveyor stands in the middle of the platform to collect its position.

2. Embrasure

An embrasure is an opening cut into the parapet through which an artillery crew could fire its weapon with less exposure to enemy fire. Embrasures are readily identified in the field by a narrow depression in the parapet behind which may be found some of the indicators discussed above—thickening of the parapet; ditch in front after ditch switching sides; visible platform; protective traverses; a ramp or cut leading into the platform. A single gun sometimes had more than one embrasure, particularly if sited in the angle of a work. In addition to the gun platform itself, each embrasure should be mapped.

3. Hole

Many miscellaneous holes are associated with linear earthworks. All of these holes served a purpose for those who dug them, but understanding that purpose is now a matter of identification and interpretation. Although many of these “holes” can be described as officers’ holes, dugouts, ammunition holes, supply caches, or picket holes, often the purpose remains ambiguous. It is best for the survey team to map the holes as holes and leave interpretation to the archeologists and historians. The point feature contains a *comment* field to allow the surveyor to label the mapped features.

4. Traverse

Traverses are shorter parapets erected perpendicular to the main defensive lines to prevent an enemy enfilading fire from sweeping down the length of a trench and inflicting heavy casualties. Traverses often separated guns that were entrenched as a battery. The surveyor collects a traverse point by standing at its end farthest from the main parapet. These points can later be used to generate traverse lines in the GIS.

5. Balk

A balk is a narrow earthen divider left in the ditch. While traverses were typically dug and piled up, a balk was simply left undug, separating one ditch segment and the next. Balks appeared to serve structural and organizational purposes. Sometimes these appear to have been left as the foundations for log traverses that have since rotted away. Other times, balks appear to have been left to separate two units in the line of battle. Mapping balks captures an important architectural detail and might enable a historian to determine the positions and fronts of individual regiments in the line of battle.

6. Hump

Humps are mapped generically in the same way as holes. While some humps could be called magazines or bombproofs, this is again a matter of interpretation or archeological confirmation. Any large mound of earth is mapped simply as a “hump.”

7. Other

Including an “other” category allows the survey team to collect features of interest that might not be categorized. An example might be a sunken portion of a parapet that resulted from the collapse of a wooden drainage culvert that passed beneath it.

8. Dimensions

As time permits, surveyors should be asked to measure the length, width, and height/depth of these features.

Point Feature: Break in Parapet <3 meters

If the gap between one trench segment and another is wide, the survey team will turn off the parapet line feature and start another at the beginning of the next segment. Longer parapets are often penetrated by various types of breaks that are too narrow to justify turning the earthworks line feature off and back on. These include breaks that were left by the soldiers and breaks that resulted from later activities, such as farming, logging, and erosion. For convenience in the field and because of the accuracy of the GPS equipment, breaks less than about 3 meters in width are mapped as point features, nested on the earthworks line. The breaks are then identified as below.

1. Engineered outlet

Breaks were often left in the parapets to allow skirmishers or artillery to go to the front or to allow egress for a road or path. An engineered break left the ground between the segments of parapet undug—the ground surface appears level and firm. Occasionally, the parapet on either side of the break might be inclined slightly to the rear. An engineered outlet is an integral part of the fortification and should be noted when it can be identified.

2. Stream /gully

Narrow breaks were left in the parapet for drainage. Although many of these technically were “engineered”, it is good to record geographic features, such as streams and gullies that can be related to the parapet. These points can be lined up with other geographic data layers in the GIS.

3. Intrusion

Post-construction intrusions caused by farming or logging, account for many breaks in the parapet encountered in the field. An intrusion for a logging or farm road is typically made by pushing a portion of the parapet back into the trench with a bulldozer or front-end loader. This leaves telltale traces—disturbed ground surface, slumping along the original ditch, slumping in the ditch on both sides of the opening, and often vehicle ruts. When there is doubt about whether a break is engineered or not, it should be mapped as an intrusion. The width of the break is collected as an attribute value.

Point Feature: Damage Point

While conducting the inventory, surveyors should note places on the earthworks where there is visible damage. The most common types of damage are human digging, animal burrows, active erosion caused by water or wind, compaction caused by foot or vehicular traffic, and wind-thrown trees that have gouged the parapet or ditch. While collecting the damage point, the surveyor should also note the predominant cover of the parapet, either plant cover or mulch and leaf litter, and the percentage of bare earth at the location. A high percentage of bare earth is a clear indicator of ongoing erosion and can identify areas that need immediate attention.

Point Feature: Anchor Point

Parapets may be full of bends and angles that should be captured during the GPS survey in order to reflect visual reality. Because many positions are averaged to compute a point feature during GPS data collection, point features are inherently more accurate than line or polygon features. To take advantage of this higher accuracy, it is important to collect point features in conjunction with a line to anchor it to the ground and assist in the editing process. These anchor points are used to mark the beginning, end, an angle, or an intersection on a line, thus improving confidence in the shape and accuracy of the line feature as mapped. Anchor points should be included in all data dictionaries to be used with any line features.

Suggested GPS Data Dictionary for Earthworks Inventory, Assessment, and Monitoring

The inventory portion of the data dictionary contains two line features and five point features with a total of thirty attribute and comment fields. Each mapped feature in the inventory should be given an identification code. The identification code is typically a temporary ID number assigned in the field. A permanent inventory number can be assigned to each parapet segment and earthworks feature after the inventory is completed.

LINE FEATURE Parapet

Attribute: Identification Code (character)

Attribute: Type of Construction (menu)

Front ditch
Rear ditch
Double ditch

Attribute: Relief in <units> (numeric)

Attribute: Width of Parapet in <units> (numeric)

Attribute: Condition (menu)

Good
Fair
Poor
Remnant

Attribute: Predominant Ground Cover (menu)

Evergreen forest
Mixed forest (evergreen & deciduous)
Deciduous forest
Meadow/pasture/grassland
Marsh/wetland
Scrub regrowth
Maintained cover

Other

Attribute: Comment (character)

LINE FEATURE Ditch

Attribute: Identification Code (character)

Attribute: Width in <units> (numeric)

Attribute: Depth in <units> (numeric)

Attribute: Standing Water? (menu)

Yes
No

Attribute: Comment (character)

POINT FEATURE Earthworks Point

Attribute: Identification Code (character)

Attribute: Feature Type (menu)

Gun platform
Embrasure
Hole/dugout
Traverse
Balk
Hump
Other

Attribute: Length in <units> (numeric)

Attribute: Width in <units> (numeric)

Attribute: Height/depth in <units> (numeric)

Attribute: Comment (character)

Note: Field measurements should be consistent with the database that is used in the park. Collect data in meters if the database projection is in utms, in feet if the projection is in state plane.

POINT FEATURE Break in Parapet <3 meters

Attribute: Type of Break (menu)

Engineered outlet (e.g. sally)
Stream /gully

Intrusion (e.g. vehicle cut)
Erosion
Other

Attribute: Width of break in <units> (numeric)

Attribute: Comment (character)

POINT FEATURE Damage Point

Attribute: Type of Damage Observed (menu)

Human digging
Animal burrow
Erosion
Compaction
Wind-thrown tree
Other

Attribute: Predominant Parapet Cover (menu)

Mulch/leaf litter
Plant cover
Other

Attribute: Exposed Soil (menu)

No exposed soil
25% exposed soil
50% or more exposed soil

Attribute: Comment (character)

POINT FEATURE Anchor Point

Attribute: Line Point Type

Begin
End
Angle
Intersection

POINT FEATURE Photo Point

Attribute: Photo ID (character)

Attribute: Subject (character)

Attribute: Direction of View (menu)

N
NE
E
SE
S
SW
W
NW

Attribute: Comment (character)

The following point features focus on specific conditions of vegetation and tree condition and require more specialized knowledge on the part of the surveyors. These could be incorporated into the inventory data dictionary and used when appropriate or incorporated into a more general maintenance data dictionary.

POINT FEATURE Vegetation Assessment

Attribute: % Plant Cover *as indication of erosion control* (menu)

>80% plant cover
60-80% plant cover
40-60% plant cover
<40% plant cover

Attribute: Maintenance Regime (menu)

None
Mowing
Cutting
Burning
Herbicide
Tree removal/trimming
Other

Attribute: Maintenance Frequency (menu)

No maintenance
1-2 treatments per year
2-4 treatments per year
5-6 treatments per year
6-8 treatments per year
>8 treatments per year

Attribute: Persistent Exotics (menu)

None observed

<25% frequency of exotics
25-50% frequency of exotics
50-75% frequency of exotics
>75% frequency of exotics

Attribute: Species Diversity (menu)

>8 average species diversity per square meter quadrant
6-8 average species diversity per square meter quadrant
4-6 average species diversity per square meter quadrant
2-4 average species diversity per square meter quadrant
1-2 average species diversity per square meter quadrant

Attribute: Legibility (menu)

Legible earthwork/attractive
Generally legible/discordant spots
Partially legible/discordant spots
Generally rough/inconsistent
Chaotic, illegible

Attribute: Comment (character)

POINT FEATURE Tree Assessment

Attribute: Tree Species (character or menu)

Attribute: Diameter at Breast Height (DBH) (numeric)

Attribute: Health (menu)

Appears healthy
Major structural damage
Minor structural damage
Appears dead or dying

Attribute: Hazardous Tree? (menu)

High
Moderate
Low
No observable hazard

Attribute: Comment (character)